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In this issue:

- An Overview of Psycho-  
physiological Studies of  
PTSD
- PILOTS Update
- PTSD Research at the  
Miami VAMC

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# The National Center for Post-Traumatic Stress Disorder PTSD RESEARCH QUARTERLY

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## AN OVERVIEW OF PSYCHO- PHYSIOLOGICAL STUDIES OF PTSD

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Individuals with PTSD consistently have been found to respond with heightened psychophysiological reactivity to trauma-related cues (DSM-III-R PTSD criterion D.6) compared to individuals without PTSD. The majority of investigations comprising this literature have been conducted within the contexts of two research paradigms. In the first paradigm standardized audio-visual cues, typically combat sounds such as mortar or gunfire and pictures of combat situations, are presented to subjects while physiological responses including heart rate (HR), blood pressure, electrodermal activity, and forehead electromyogram (EMG) are recorded (Blanchard et al., 1982; Blanchard et al., 1986; Blanchard et al., 1989; Malloy et al., 1983; McFall et al., 1990; Pallmeyer et al., 1986). Combat veterans with PTSD produce larger-magnitude HR and blood pressure responses during exposure to combat-related audio-visual cues compared to veterans without PTSD. Skin conductance (SC) and forehead EMG results have provided less reliable PTSD vs. non-PTSD differentiation within this paradigm, perhaps because of the methodologies employed for recording them. Standardized word stimuli have also been used; McNally et al. (1987) reported larger SC responses to combat-related words in Vietnam veterans with PTSD compared to a group of combat veterans with non-PTSD psychiatric disorders.

The second paradigm uses script-driven imagery to assess physiological reactivity while subjects recollect a variety of experiences. Short vignettes (scripts) approximately 30 sec. in duration are derived from an individual's traumatic and non-traumatic life experiences. These scripts are then tape-recorded and played back in the psychophysiology laboratory. Studies of Vietnam, WWII, and Korean veterans (Orr et al., 1993; Pitman et al., 1987; Pitman et al., 1990) have found larger SC, HR, and facial EMG (lateral frontalis) responses during imagery of personal combat experiences in veterans with combat-related PTSD compared to combat veterans without PTSD. A recent study by Shalev et al. (1993) has extended these imagery findings to an Israeli sample of individuals who experienced non-combat traumatic events, including physical assault, motor vehicle accidents, and terrorist attacks. Blanchard and colleagues (1991) have also recently reported elevated HR responses during imagery of a motor vehicle accident in a small sample of indi-

viduals with PTSD resulting from the accident. These latter two studies suggest that findings obtained from combat veterans with PTSD extend to non-combat-related PTSD.

Conditioning theory provides a useful framework for conceptualizing the increased physiological reactivity observed in individuals with PTSD (e.g., Pitman, 1988). Through Pavlovian conditioning a set of cues becomes associated with a traumatic event and the powerful emotions that accompany this experience. Subsequently, these cues become capable of evoking intense emotional responses, as revealed in the heightened physiological reactivity. The two research paradigms discussed above can be viewed as different methods for presenting cues capable of activating the memory network, within which trauma-related information is encoded, and its accompanying emotional and behavioral responses. PTSD resulting from events such as combat or motor vehicle accidents appears to be associated with elevated psychophysiological reactivity that is quite specific to trauma-related cues. There do not appear to be differences between PTSD vs. non-PTSD subjects in autonomic reactivity to standard laboratory stressors such as mental arithmetic (Blanchard et al., 1982, 1986, 1989; Pallmeyer et al., 1986). Also, PTSD subjects' psychophysiological responses to non-trauma-related imagery generally do not differ in magnitude from those of non-PTSD subjects (Orr et al., 1993; Pitman et al., 1987, 1990; Shalev et al., 1993). The elevation and specificity of the reactivity observed in PTSD subject samples studied to date are similar to those reported for individuals with simple phobia (Cook et al., 1988; McNeil et al., 1993). Individuals with simple phobia show larger HR and SC responses during imagery of the phobic object compared to other anxious groups with less specific fears. This heightened reactivity is confined to imagery of the phobic object, as is the case for PTSD. Specificity of the fear seems to be important; panic-disordered patients have been found to be unresponsive during imagery of their fear-related contexts (Cook et al., 1988; Zander & McNally, 1988).

Overall, psychophysiological measures of reactivity to trauma-related cues appear to provide good discrimination of PTSD from non-PTSD cases. Sensitivities and specificities for the studies of combat veterans and Israeli trauma victims noted above range from approximately 60-90 percent and 80-100 percent, respectively. Furthermore, measures of physiological reactivity appear to provide reason-

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ably good discrimination even when subjects are attempting to hide or exaggerate their responses (Gerardi et al., 1989; Orr & Pitman, 1993). Psychophysiological reactivity during trauma-related imagery has also been shown to correlate well with a variety of measures of self-reported psychopathology (Orr et al., 1990). These encouraging results suggest that assessments of physiological reactivity to trauma-related cues can provide information that will assist in making diagnostic decisions and assessing treatment outcome. For example, Pitman and Orr (1993) have discussed the potential utility of psychophysiological assessment as an adjunct to forensic psychiatric evaluations. Keane and Kaloupek (1982) reported that improvement following imaginal flooding was associated with a reduction in HR response magnitude during recollection of the trauma in a case of combat-related PTSD. Psychophysiological responses during trauma-related imagery have been found to be sensitive to psychiatric improvement following a systematic desensitization procedure (Shalev, Orr & Pitman, 1992). Boudewyns and Hyer (1990) reported that a reduction in SC response magnitude during trauma-related imagery following treatment was associated with a relatively higher "adjustment" score at three months post-treatment.

Psychophysiological studies have also focused on the exaggerated startle response in PTSD (DSM-III-R PTSD criterion D.5) through the measurement of eyeblink EMG, HR, and SC responses to intense auditory stimuli. Individuals with PTSD show evidence of larger-magnitude eyeblink EMG responses to intense auditory stimuli (Butler et al., 1990; Shalev, Orr, Peri, Schreiber & Pitman, 1992). Across repeated presentations of such stimuli individuals with PTSD also show larger-magnitude HR responses and slower habituation of SC response magnitude compared to individuals without PTSD (Paige et al., 1990; Shalev, Orr, Peri, Schreiber & Pitman, 1992). However, PTSD subjects do not show slower habituation of eyeblink responses (Ross et al., 1989; Shalev, Orr, Peri, Schreiber & Pitman, 1992). The findings from these studies of psychophysiological reactivity to intense auditory stimuli are important because they provide an empirical bridge to other anxiety disorders.

Findings from the habituation studies are especially interesting in light of evidence suggesting that genetic factors play a role in determining autonomic reactivity (Boomsma & Gabrielli, 1985; Kotchoube, 1987; Lykken et al., 1988). The larger-magnitude and more slowly habituating autonomic responses observed for the various anxiety disorders, including PTSD, may reflect genetic influences rather than anxiety per se. It is likely that the larger-magnitude eyeblink responses do result from the presence of a negatively valenced emotional state such as anxiety or fear that is present in the PTSD subjects. Across several studies Lang's group has demonstrated that EMG response magnitude is increased by negative emotion and decreased by positive emotion (e.g., Bradley et al., 1990). This influence is determined by the valence of the emotional state rather than the associated arousal. If these

assertions regarding the genetic and emotional bases of physiological reactivity are correct, autonomic measures might provide a vulnerability marker for the development of PTSD (or an anxiety disorder). Eyeblink EMG magnitude may provide an index of the level of current emotional distress and might be used to assess changes in the severity of symptomatology. The larger magnitude and slower habituation of autonomic responses to repeatedly presented intense auditory stimuli suggest a common dimension linking PTSD, GAD, agoraphobia, and panic disorder but not simple phobia. Note that this contrasts with findings from the imagery studies suggesting that psychophysiological reactivity of PTSD subjects is similar to that of patients with simple phobia and not agoraphobia/panic disorder.

Although findings of increased psychophysiological reactivity to trauma-related cues and repeatedly presented intense auditory stimuli in PTSD appear to be robust, the data on whether or not PTSD is associated with tonic elevations of physiological levels, particularly autonomic variables, are inconclusive. Typically, this issue has been addressed within the context of studies examining psychophysiological reactivity by recording resting physiological levels for some period prior to exposure to the trauma-related imagery or audio-visual cues. Unfortunately, the results of statistical comparisons of the PTSD and non-PTSD subjects' resting levels are not always presented. A review of this work (see Blanchard, 1990) suggests a trend towards elevated HR and blood pressure levels in PTSD subjects compared to non-PTSD controls. However, three imagery studies (Orr et al., 1993; Pitman et al., 1990; Shalev et al., 1993) have found that the resting HR levels of PTSD subjects were not significantly higher than those of non-PTSD subjects. An important problem with this approach is the likelihood that anxiety generated by the anticipation of the trauma-related stimuli will increase the psychophysiological levels recorded during baselines. McFall and colleagues (1992) found that resting HR and blood pressure levels did not significantly differ between combat veterans with PTSD and those without PTSD in a study where subjects were not anticipating exposure to trauma-related cues.

Information-processing abnormalities in PTSD have recently been examined through the measurement of event-related potentials (ERPs). This technique entails recording electroencephalographic scalp potentials that are generated by the presentation of discrete stimuli (such as tones) and averaging over multiple trials. The resulting waveform is then analyzed in terms of the amplitude and latency of characteristic positive (e.g., P200, P300) and negative (e.g., N100, N200, N400) components. To date, two published studies have used ERPs to investigate information processing in PTSD. Paige and colleagues (1990) examined the early sensory components of the ERP waveform using an augmentation-reduction paradigm. They found that PTSD subjects demonstrated a reduction in P200 amplitude in response to increasing tone intensities, a pattern opposite to that found in non-PTSD subjects. The

authors suggested that this finding reflects an elevated CNS sensitivity in PTSD and the attempt of the cortex to reduce stimulation. McFarlane and colleagues (1993) measured ERPs during presentations of frequent, infrequent, and distractor tones to examine the later stages of stimulus processing in PTSD. PTSD subjects, relative to controls, demonstrated a longer-latency N200 and attenuated P300 to the infrequently presented and distractor tones, suggesting that PTSD subjects had more difficulty discriminating these stimuli. McFarlane et al. suggested that these findings may reflect the disturbed concentration found in PTSD.

The literature on psychophysiology and PTSD has grown considerably over the past ten years, but there remain many important unanswered questions. For example, the generality of the finding of increased physiological reactivity to trauma-related cues in combat veterans with PTSD needs to be extended to other trauma populations. Because combat veterans have served as the primary subjects in most of the psychophysiological studies, conclusions are also limited to inferences about chronic PTSD; very little is known about the tonic or phasic psychophysiology of acutely traumatized individuals. Once an individual is no longer symptomatic for PTSD, do all aspects of psychophysiological responding become normalized? Can psychophysiological reactivity be used to screen individuals who may be at high risk for developing PTSD if exposed to a traumatic event or, following a traumatic experience, to predict the development of PTSD? It will also be important to explore the long-term consequences of heightened reactivity in individuals with chronic PTSD in light of evidence suggesting that increased HR reactivity is associated with an elevated risk for heart disease. Future research must also examine the role that individual differences play in the acquisition and maintenance of the emotional responses associated with PTSD. Why do some individuals develop PTSD and its characteristic physiological reactivity while others do not even though they are exposed to similar traumatic events; is there a difference in the conditionability of these individuals? Interestingly, Öhman and Bohlin (1973) have reported that individuals who show slower SC response habituation (as has been observed in PTSD) also show stronger conditioning.

Reviews of psychophysiological research on PTSD can be found in Blanchard (1990), McFall et al. (1989), Orr (1990), and Shalev and Rogel-Fuchs (1993). Pitman (1993) has also discussed the implications of biological, including psychophysiological, findings for the classification of PTSD in the forthcoming DSM-IV. Cacioppo and Tassinari (1990) is an excellent reference book for psychophysiological principles and methods.

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- MCNEIL, D.W., VRANA, S.R., MELAMED, B.G., CUTHBERT, B.N. & LANG, P.J. (1993). **Emotional imagery in simple and social phobia: Fear versus anxiety.** *Journal of Abnormal Psychology*, 102, 212-225.
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- BLANCHARD, E.B., KOLB, L.C., GERARDI, R.J., RYAN, P. & PALLMEYER, T.P. (1986). **Cardiac response to relevant stimuli as an adjunctive tool for diagnosing post-traumatic stress disorder in Vietnam veterans.** *Behavior Therapy*, 17, 592-606. The cardiac responses of 91 Vietnam combat veterans, who either met (n=57) or did not meet (n=34) the DSM-III criteria for PTSD, were examined to a neutral stressor of mental arithmetic or to a relevant stressor of progressively louder (40 to 80 db) combat sounds. Examination of individual subject data reveals that one can accurately identify 70.2 percent of PTSD veterans and 88.2 percent of combat veterans, with only 9.7 percent false positives, using a single cutoff score on the highest heart rate response to combat sounds.
- BLANCHARD, E.B., KOLB, L.C. & PRINS, A. (1991). **Psychophysiological responses in the diagnosis of posttraumatic stress disorder in Vietnam veterans.** *Journal of Nervous and Mental*



*Disease*, 179, 99-103. In an initial sample of 104 male Vietnam combat veterans, we found that five heart rate parameters from a psychophysiological assessment could correctly discriminate 75 percent of the sample into those with PTSD and those without it. Using a stepwise approach, we found adding ten blood pressure parameters increased discrimination to 80 percent, while adding five parameters from frontal electromyograms did not increase discrimination. Cross-validation of the heart rate parameters on a new sample of 96 veterans resulted in 83 percent correct discrimination.

BOUDEWYNS, P.A. & HYER, L. (1990). **Physiological response to combat memories and preliminary treatment outcome in Vietnam veteran PTSD patients treated with direct therapeutic exposure.** *Behavior Therapy*, 21, 63-87. Abstracted in *PTSD Research Quarterly*, 4(2), 1993.

BUTLER, R.W., BRAFF, D.L., RAUSCH, J.L., JENKINS, M.A., SPROCK, J. & GEYER, M.A. (1990). **Physiological evidence of exaggerated startle response in a subgroup of Vietnam veterans with combat-related PTSD.** *American Journal of Psychiatry*, 147, 1308-1312. One of the diagnostic criteria for PTSD is an exaggerated startle response; however, this phenomenon has not been verified empirically. The authors compared 20 Vietnam combat veterans with PTSD and 18 combat veterans without PTSD on the eyeblink reflex electromyographic response of the startle reaction. Subjects in both groups who failed to show an eyeblink response to the startle stimuli were eliminated from further analyses. Among the remaining subjects, the 13 with PTSD had a significantly greater startle response amplitude than the 12 control subjects at intermediate intensities of acoustic stimuli. The relationship between startle responsivity and both negative and positive symptoms was also investigated.

GERARDI, R.J., BLANCHARD, E.B. & KOLB, L.C. (1989). **Ability of Vietnam veterans to dissimulate a psychophysiological assessment for post-traumatic stress disorder.** *Behavior Therapy*, 20, 229-243. Abstracted in *PTSD Research Quarterly*, 1(1), 1990.

MALLOY, P.F., FAIRBANK, J.A. & KEANE, T.M. (1983). **Validation of a multimethod assessment of posttraumatic stress disorders in Vietnam veterans.** *Journal of Consulting and Clinical Psychology*, 51, 488-494. Abstracted in *PTSD Research Quarterly*, 3(4), 1992.

MCFALL, M.E., MURBURG, M.M., KO, G.N. & VEITH, R.C. (1990). **Autonomic responses to stress in Vietnam combat veterans with posttraumatic stress disorder.** *Biological Psychiatry*, 27, 1165-1175. Abstracted in *PTSD Research Quarterly*, 1(2), 1990.

MCFALL, M.E., VEITH, R.C. & MURBURG, M.M. (1992). **Basal sympathoadrenal function in posttraumatic distress disorder.** *Biological Psychiatry*, 31, 1050-1056. Research has consistently shown that patients with PTSD manifest greater changes in heart rate, blood pressure, and plasma epinephrine than controls when exposed to trauma-related laboratory stressors. However, findings are equivocal as to whether PTSD subjects differ from controls on basal, or tonic, measures of autonomic activity. In this study, PTSD patients (n = 11) and asymptomatic controls (n = 11) were compared on measures of basal sympathoadrenal function, including plasma norepinephrine and epinephrine as well as heart rate and blood pressure. Results showed that PTSD patients were not significantly different from control subjects on any measure. Although phasic alterations in autonomic function in PTSD have been consistently found in previous research, this

study suggests that tonic sympathetic nervous system activity in PTSD patients may not differ from that of healthy controls.

MCFARLANE, A.C., WEBER, D.L. & CLARK, C.R. (1993). **Abnormal stimulus processing in posttraumatic stress disorder.** *Biological Psychiatry*, 34, 311-320. This study investigated event-related potential (ERP) indices of information processing in sufferers of PTSD. ERPs were obtained from 18 PTSD patients and 20 controls while they performed a target discrimination task requiring the detection of infrequent target tones from a background sequence of frequent and infrequent distractor tones. A delayed N2 and an attenuated P3 that failed to differentiate target from distractor tones indicated that patients had abnormal difficulty distinguishing task stimuli of differing relevance. It is proposed that this difficulty is reflected behaviorally in the slowed reaction time by patients to target stimuli and may underlie the disturbed concentration and memory impairments found in PTSD. It may also be related to dysfunction in central noradrenaline function, which has been shown to be both crucial in selective attention and abnormal in PTSD.

MCNALLY, R.J., LUEDKE, D.L., BESYNER, J.K., PETERSON, R.A., BOHM, K. & LIPS, O.J. (1987). **Sensitivity to stress-relevant stimuli in posttraumatic stress disorder.** *Journal of Anxiety Disorders*, 1, 105-116. This study investigated perceptual and physiological sensitivity to stimuli semantically associated with trauma in 10 Vietnam combat veterans with PTSD. We used an auditory recognition task in which subjects were presented with target words related to Vietnam stressors (e.g., Firefight), phonetically similar words (e.g., Firefly), and neutral words (e.g., Fingertips). Skin conductance responses (SCRs) occurring to detected targets were also measured. 10 combat and 10 noncombat veterans with other psychiatric disorders served as control subjects. We hypothesized that, in comparison to controls, PTSD subjects should: (a) detect more stress targets than neutral targets, (b) exhibit larger SCRs to detected stress targets than to detected neutral targets, and (c) misperceive phonetically similar words as stress words. Although all groups detected more stress than neutral targets, only PTSD subjects exhibited enhanced SCRs to detected stress targets. This suggests that retrieval of trauma-related information from memory is accompanied by physiological responses consistent with fear in subjects with PTSD.

ORR, S.P., CLAIBORN, J.M., ALTMAN, B., FORGUE, D.F., DE JONG, J.B., PITMAN, R.K. & HERZ, L.R. (1990). **Psychometric profile of posttraumatic stress disorder, anxious, and healthy Vietnam veterans: Correlations with psychophysiologic responses.** *Journal of Consulting and Clinical Psychology*, 58, 329-335. Three groups of Vietnam combat veterans, PTSD (n = 25), anxious (n = 7), and healthy (n = 18), completed a battery of psychometric tests. Measurement of psychophysiologic responses to imagery of individualized combat experiences followed the psychometrics. The PTSD subjects differed significantly from the healthy subjects on almost all measures but showed fewer differences from the anxious subjects. The typical PTSD subject was characterized as anxious, depressed, prone to dissociation, and external in locus of control. Correlations with the physiologic responses supported the validity of psychometric scales specifically designed to measure PTSD but cast doubt on the interpretation of traditional measures of overreporting or dissimulation in this disorder.

ORR, S.P., PITMAN, R.K., LASKO, N.B. & HERZ, L.R. (1993). **Psychophysiological assessment of posttraumatic stress disorder imagery in World War II and Korean combat veterans.** *Journal of Abnormal Psychology*, 102, 152-159. We assessed the heart

rate, skin conductance, and left lateral frontalis electromyographic responses of World War II (WWII) and Korean War male veterans to recollection of their combat experiences by using a script-driven imagery technique previously validated in Vietnam veterans. Medication-free subjects were classified on the basis of criteria from DSM-III-R into PTSD ( $n = 8$ ) and non-PTSD ( $n = 12$ ) groups, which did not differ in overall combat exposure or severity of personal combat events. PTSD subjects' physiological responses during personal combat imagery were markedly larger than those of non-PTSD subjects', even though the self-reported emotional responses of the two groups were comparable. A physiological discriminant function derived from Vietnam veterans correctly classified 7 of the 8 PTSD subjects (sensitivity was 88 percent) and 12 of the 12 non-PTSD subjects (specificity was 100 percent;  $p < .001$ ).

PAIGE, S.R., REID, G.M., ALLEN, M.G. & NEWTON, J.E.O. (1990). **Psychophysiological correlates of posttraumatic stress disorder in Vietnam veterans.** *Biological Psychiatry*, 27, 419-430. Abstracted in *PTSD Research Quarterly*, 1(2), 1990.

PITMAN, R.K., ORR, S.P., FORGUE, D.F., ALTMAN, B., DE JONG, J.B. & HERZ, L.R. (1990). **Psychophysiological responses to combat imagery of Vietnam veterans with posttraumatic stress disorder versus other anxiety disorders.** *Journal of Abnormal Psychology*, 99, 49-54. We used psychophysiological techniques to assess responses to imagery of psychologically stressful past experiences in medication-free Vietnam combat veterans classified, on the basis of DSM-III-R criteria into PTSD ( $n = 7$ ) or non-PTSD anxiety disorder (anxious;  $n = 7$ ) groups. Scripts describing each individual's combat experiences were recorded and played back in the laboratory. Subjects were instructed to imagine the events the scripts portrayed while heart rate, skin conductance, and frontalis electromyogram were recorded. PTSD subjects' physiologic responses were higher than those of anxious subjects. A discriminant function derived from a previous study of PTSD and mentally healthy combat veterans identified 5 of the 7 current PTSD subjects as physiologic responders and all 7 of the anxious subjects as nonresponders. Results of this study replicate and extend results of the previous study and support the validity of PTSD as a separate diagnostic entity.

PITMAN, R.K., ORR, S.P., FORGUE, D.F., DE JONG, J.B. & CLAIBORN, J.M. (1987). **Psychophysiological assessment of posttraumatic stress disorder imagery in Vietnam combat veterans.** *Archives of General Psychiatry*, 44, 970-975. Abstracted in *PTSD Research Quarterly*, 3(4), 1992.

ROSS, R.J., BALL, W.A., COHEN, M.E., SILVER, S.M., MORRISON, A.R. & DINGES, D.F. (1989). **Habituation of the startle reflex in posttraumatic stress disorder.** *Journal of Neuropsychiatry and Clinical Neurosciences*, 1, 305-307. The authors investigated habituation of the eye-blink component of the startle reflex to repeated affectively neutral tactile and auditory stimuli in nine subjects with PTSD and nine controls. Each group showed rapid habituation in both tactile and auditory modalities.

SHALEV, A.Y., ORR, S.P., PERI, T., SCHREIBER, S. & PITMAN, R.K. (1992). **Physiologic responses to loud tones in Israeli patients with posttraumatic stress disorder.** *Archives of General Psychiatry*, 49, 870-875. Orbicularis oculi (eye blink) electromyogram, skin conductance, and heart rate responses to 15 consecutive 95-dB, 500-millisecond, 1000-Hz tones with 0-millisecond rise and fall times were measured in 14 patients with PTSD, 14 patients

with other anxiety disorders, 15 mentally healthy subjects with past traumatic experiences, and 19 mentally healthy subjects with no trauma history. The patients with PTSD showed significantly larger skin conductance and heart rate responses and a trend toward larger electromyogram responses to the tones than every other group. These effects were not explained by subjective anxiety, resting physiologic arousal, physiologic arousal preceding the tone trials, or initial physiologic responsivity. The group with PTSD was the only one that failed to show habituation of skin conductance responses.

SHALEV, A.Y., ORR, S.P. & PITMAN, R.K. (1993). **Psychophysiological assessment of traumatic imagery in Israeli civilian patients with posttraumatic stress disorder.** *American Journal of Psychiatry*, 150, 620-624. Objective: This study used a script-driven imagery technique, previously used with combat veterans, to assess physiologic responses of Israeli survivors of noncombat traumas. Method: Each subject had experienced an event meeting DSM-III-R criterion A for PTSD. The subjects were classified on the basis of the full DSM-III-R criteria into a current PTSD group ( $N = 13$ ) and a non-PTSD group ( $N = 13$ ). 30-second scripts describing each subject's personal traumatic event, as well as other events, were prepared. The scripts incorporated subjective visceral and muscular responses reported to have accompanied each experience. In the laboratory, the scripts were read one at a time to the subject, who was instructed to imagine each event portrayed as vividly as possible, while heart rate, skin conductance, and left lateral frontalis electromyogram levels were measured. Results: Multivariate analysis of variance revealed that the physiologic responses of the PTSD subjects during imagery of their personal traumatic experiences were significantly greater than those of the non-PTSD subjects. This difference was not explained by age, gender, or rated severity of the traumatic event. A physiologic discriminant function derived from previously studied Vietnam veterans correctly classified 9 of the 13 PTSD subjects (sensitivity = 69 percent) and 10 of the 13 non-PTSD subjects (specificity = 77 percent). Conclusions: These results replicate previous findings of heightened physiologic responses during personal combat imagery in male American war veterans and extend them to a group of male and female Israeli civilian victims of trauma, supporting the robustness of physiologic responding during personal traumatic imagery as a measure of PTSD.

SHALEV, A.Y., ORR, S.P. & PITMAN, R.K. (1992). **Psychophysiological response during script-driven imagery as an outcome measure in posttraumatic stress disorder.** *Journal of Clinical Psychiatry*, 53, 324-326. Background: A psychophysiological method previously validated in Vietnam veterans was used to evaluate the responses of medication-free Israeli PTSD patients to script-driven imagery, before and after treatment with systematic desensitization. Method: Skin conductance, heart rate, and frontalis EMG responses during imagery of traumatic events were assessed in three unmedicated Israeli PTSD patients. The test of significance was used to compare the magnitude of the response to traumatic imagery with that of responses to imagery of nine other events. Results: The elevated physiologic responses to traumatic imagery, observed before treatment, normalized after systematic desensitization. Imagery of traumata that were not treated by desensitization continued to produce elevated responses. Conclusion: Physiologic response during traumatic imagery may be useful in the evaluation of differential treatment outcome in PTSD.

## ADDITIONAL CITATIONS

### Annotated by the Editors

BLANCHARD, E.B. (1990). **Elevated basal levels of cardiovascular responses in Vietnam veterans with PTSD: A health problem in the making?** *Journal of Anxiety Disorders*, 4, 233-237. Reviews 8 studies of psychophysiological reactivity to combat stimuli among male combat veterans. The author notes an average elevation in baseline heart rate of 10.3 bpm among those with PTSD, relative to those without PTSD, and speculates that this chronic elevation may lead to increased risk of cardiovascular disease in PTSD.

BLANCHARD, E.B., HICKLING, E.J. & TAYLOR, A.E. (1991). **The psychophysiology of motor vehicle accident related posttraumatic stress disorder.** *Biofeedback and Self-Regulation*, 16, 449-458.

Measured heart rate, blood pressure, and skin conductance reactivity to mental arithmetic and personal accident imagery in 4 motor vehicle accident survivors who had PTSD. The average increase in heart rate to the accident imagery was 9.2 bpm whereas the other measures showed less consistent responsiveness. Heart rate increases in response to mental arithmetic ranged from 10-15 bpm.

BLANCHARD, E.B., KOLB, L.C., PALLMEYER, T.P. & GERARDI, R.J. (1982). **A psychophysiological study of post traumatic stress disorder in Vietnam veterans.** *Psychiatric Quarterly*, 54, 220-229.

Compared 11 male Vietnam combat veterans with PTSD to 11 age- and sex-matched nonveteran controls on psychophysiological reactions to combat and non-combat stressors. The PTSD group showed increased heart rate, systolic blood pressure, and forehead EMG responses. Heart rate alone correctly classified 95.5% of the sample.

BLANCHARD, E.B., KOLB, L.C., TAYLOR, A.E. & WITTROCK, D.A. (1989). **Cardiac response to relevant stimuli as an adjunct in diagnosing post-traumatic stress disorder: Replication and extension.** *Behavior Therapy*, 20, 535-543.

Attempted to replicate an earlier study by comparing 59 male combat veterans with PTSD to 12 male combat controls on heart rate reactivity to combat and noncombat stressors. Despite generally lower heart rates among the new PTSD group, relative to the original sample, the finding of greater reactivity to combat stimuli among PTSD patients was replicated.

KEANE, T.M. & KALOUPEK, D.G. (1982). **Imaginal flooding in the treatment of a posttraumatic stress disorder.** *Journal of Consulting and Clinical Psychology*, 50, 138-140.

Used exposure therapy to treat a 36-year-old male Vietnam veteran with PTSD and assessed treatment efficacy using measures that included heart rate reactivity to intrusive thoughts. The authors report that heart rate reactivity declined following treatment.

MCFALL, M.E., MURBURG, M.M., ROSZELL, D.K. & VEITH, R.C. (1989). **Psychophysiologic and neuroendocrine findings in posttraumatic stress disorder: A review of theory and research.** *Journal of Anxiety Disorders*, 3, 243-257.

Jointly reviews psychophysiological and neuroendocrine studies of PTSD. One of the authors' conclusions is that future research should adequately match PTSD and non-PTSD groups for other

comorbid diagnoses. Another conclusion is that attempts to use psychophysiological and biological information for case identification have greater specificity than sensitivity.

ORR, S.P. (1990). **Psychophysiological studies of posttraumatic stress disorder.** In E.L. Giller (Ed.), *Biological assessment and treatment of posttraumatic stress disorder* (pp. 135-157). Washington: American Psychiatric Press.

Reviews psychophysiological studies of PTSD resulting from combat and noncombat trauma. The author notes that the tonic autonomic hyperarousal seen in many studies comparing PTSD and no-PTSD groups is misleading because chronic hyperarousal is seen in many anxiety disorders. Instead, he emphasizes the importance of reactivity to trauma-related stimuli and imagery for identifying PTSD.

ORR, S.P. & PITMAN, R.K. (1993). **Psychophysiologic assessment of attempts to simulate posttraumatic stress disorder.** *Biological Psychiatry*, 33, 127-129.

Studied 25 male combat veterans with PTSD and 18 male combat controls in order to test the ability of non-PTSD veterans to simulate PTSD-like psychophysiological responses during personal combat imagery. Although the combat controls were able to simulate increased heart, they were unable to successfully simulate skin conductance and facial EMG responses, especially corrugator activity.

PALLMEYER, T.P., BLANCHARD, E.B. & KOLB, L.C. (1986). **The psychophysiology of combat-induced post-traumatic stress disorder in Vietnam veterans.** *Behaviour Research and Therapy*, 24, 645-652.

Studied psychophysiological reactivity to combat and neutral stressors in 12 Vietnam combat veterans with PTSD, 10 combat controls, 5 combat controls with other psychiatric disorders, 5 era veterans, and 8 noncombat controls with non-PTSD anxiety disorders. Only reactivity to combat sounds was able to distinguish the PTSD group from the combat control group, and the PTSD group from all other groups combined.

PITMAN, R.K. (1993). **Biological findings in posttraumatic stress disorder: Implications for DSM-IV classification.** In J.R.T. Davidson & E.B. Foa (Eds.), *Posttraumatic stress disorder: DSM-IV and beyond* (pp. 173-189). Washington, DC: American Psychiatric Press.

Reviews biological findings on PTSD in terms of their relevance for diagnosis and the refinement of existing diagnostic criteria. The author suggests that PTSD be classified as a distinct posttraumatic disorder, rather than as an anxiety disorder.

PITMAN, R.K. & ORR, S.P. (1993). **Psychophysiologic testing for post-traumatic stress disorder: Forensic psychiatric application.** *Bulletin of the American Academy of Psychiatry and the Law*, 21, 37-52.

Briefly reviews the literature on psychophysiological assessment of PTSD as background for discussing the use of psychophysiological reactivity as relevant information in a court of law. The authors describe how data from research studies can be used to evaluate a single case and review significant case law involving PTSD.



SHALEV, A.Y. & ROGEL-FUCHS, Y. (1993). **Psychophysiology of the posttraumatic stress disorder: From sulfur fumes to behavioral genetics.** *Psychosomatic Medicine*, 55, 413-423.

Extensively reviews the literature on psychophysiological assessment of combat and noncombat PTSD, including earlier papers on neurophysiological theories of stress disorders. Special attention is paid to recent studies of startle reactivity. The authors also discuss the relevance of psychophysiological findings for neurophysiological theories of PTSD.

## PILOTS UPDATE

Many PILOTS users ask us how they can obtain copies of journal articles, book chapters, and other materials that they have located using the database, as we are not able to supply these materials. We hope that these suggestions will help you to obtain what you need.

For American users, the first place to begin is your local library. If you have access to a medical library, ask the librarian to get copies from the regional medical library system. (All VA medical libraries are part of this system, as are most hospital and medical school libraries.) Many public and academic libraries belong to networks that make the resources of large libraries available to the clients of smaller ones. In some cases materials can be provided free of charge; otherwise, you may have to pay a small fee for each article you request. (If your request does not come under the "fair use" provision of the copyright laws, there may also be a royalty fee payable to the publisher that your library will have to collect.) Your local librarian will know the fastest and cheapest ways to get what you need.

Similar resource sharing arrangements exist in many other countries. PILOTS users in countries where libraries cannot supply needed publications should use the British Library Document Supply Centre at Boston Spa, Wetherby, West Yorkshire LS23 7BQ, United Kingdom.

There are several organizations and companies that specialize in providing rapid copies of publications.

*Information brokers* offer a complete range of services, from searching databases to providing copies. Document delivery services offer copies of materials from their own resources and often from other library collections. If your needs require it, and you are willing to pay the extra costs involved, you can receive copies by courier or fax. Information brokers can be found in the Yellow Pages, and in the "Brokers Mart" listing published in *Database* magazine. Their trade association is:

Association of Independent Information Professionals  
203 Pinehurst Road  
Canyon, California 94516  
(510) 530-3635

*Document delivery services* are operated by private companies, nonprofit organizations, and libraries. They usually offer a wide range of ordering and payment arrangements, accommodating users whose needs range from the single article to thousands of papers each year. Many are able to accept orders by electronic mail. In addition to many

services that specialize in material on a particular subject or from a particular region, there are several whose resources allow them to offer a comprehensive service. Among these are:

- CARL Systems, Inc.  
("Uncover")  
3801 East Florida Avenue  
Building D, Suite 300  
Denver, Colorado 80222  
(303) 758-3030
- University Microfilms, Inc.  
("Article Clearinghouse")  
300 North Zeeb Road  
Ann Arbor, Michigan 48106  
(800) 521-0600
- Institute for Scientific Information  
("The Genuine Article")  
3501 Market Street  
Philadelphia, Pennsylvania 19104  
(215) 386-0100
- British Library Document Supply Centre  
1 Appleton Street  
Boston, Massachusetts 02116  
(800) 932-3575

We give here their American addresses; your local library can help you locate their offices or agencies serving other countries, and can help you locate other document delivery services.

Although our PTSD Resource Center contains copies of all publications indexed in the PILOTS database, we are unable to supply copies of these documents to PILOTS users. In order to keep the PILOTS database up to date, our staff of three must devote their time to identifying, acquiring, and indexing publications on traumatic stress, as well as preparing the database for searching, writing instructional materials, and providing technical assistance to PILOTS users. We have neither the staff nor the facilities to receive requests, retrieve the documents, make photocopies, and prepare them for mailing. Furthermore, we are not in a position to make the legal and financial arrangements necessary to comply with copyright laws and guidelines.

One possible way around this would be to contract with an outside organization to provide a document delivery service to PILOTS users. This contractor would receive orders, handle all the details of fulfillment, and be responsible for all matters of copyright compliance and royalty payments. As a preliminary to further investigation of this approach, we would like to get some idea of how much interest PILOTS database users and other PTSD workers might have in such a service. Please send your comments to:

Fred Lerner, D.L.S., Information Scientist  
National Center for Post-Traumatic Stress Disorder  
VA Medical Center (116D)  
White River Junction, Vermont 05009 USA  
or by electronic mail to:  
ptsd@dartmouth.edu

## PTSD RESEARCH AT THE MIAMI VAMC

Thomas A. Mellman, MD

Efforts to integrate research activity with clinical work in PTSD in the Miami VAMC date to the early 1980s. At that time Fernando Milanes, MD, currently the Chief of the Psychiatry Service, and several collaborating clinicians conducted a pilot, open-label study of phenelzine treatment. During an overlapping time period, Tim Starkey, PhD, and Larry Ashlock, PhD, described the development of an inpatient treatment program, and later reported on psychometric correlates of factitious presentations.

The present clinical and research program evolved from a specialty clinic that was initiated in 1988 by Dr. Milanes and then developed by Tom Mellman, MD, who is currently the program director. The first wave of referrals consisted of mostly functional outpatients who were veterans of Vietnam, Korean, and WWII combat and included former prisoners of war. Structured evaluations of psychosocial, military, medical, and lifetime psychiatric histories were conducted by Dr. Mellman, Charlen Randolph, MSW, and several electively involved psychiatry residents. Findings were published in a paper that emphasized the specific phenomenology of PTSD comorbidity and longitudinal progression of illness.

While the clinical program was getting off the ground, we began to study sleep in PTSD. Our efforts were catalyzed by the serendipitous arrivals of Bruce Nolan, MD, and Renee Kulick-Bell, and the receipt of Merit Review funding in 1991. Dr. Nolan is a neurologist and certified polysomnographer who returned to Miami in 1990 and assumed the directorship of the then-new VAMC/University sleep laboratory. He continues to provide collaborative support to the PTSD sleep research effort. Ms. Bell had been the coordinator for the VA cooperative study "Psychophysiology of Chronic PTSD" at the Albany site, moved to South Florida within a week of the sleep project position being posted, and has coordinated these study efforts since.

This work has recently progressed to where it is being featured in presentations and manuscript submissions. Our descriptive assessments document a profile of sleep symptomatology in PTSD that includes recurrent awakenings, some with startle or panic features and others with dream recall, and excessive body movement. The sleep laboratory assessments tend to corroborate the subjective symptom profile, with findings of increased entries to wake during sleep and a subgroup manifesting limb movements or gross body movements during sleep. From these findings we have hypothesized a process where heightened arousal states intrude into sleep which is normally a restorative state of diminished arousal. Other emerging findings include increased REM phasic activity with PTSD, a partial association of symptomatic awakenings and REM, and the absence of a normal diminution of a noradrenergic metabolite (MHPG) at night from split urine collections.

At the time the VAMC program was being developed we initiated clinical activities in anxiety and PTSD at a non-VA, University of Miami, Department of Psychiatry setting.

Research in the non-VA component of the program has been recently enhanced by the full-time involvement of a clinical-research fellow, Daniella David, MD, and receipt of an NIMH RAPID award to study Hurricane Andrew effects. Specific investigations have focused on developmental trauma histories among adults with panic/phobic conditions, phenomenology of psychiatric morbidity related to Hurricane Andrew and severe motor vehicle accidents, and sleep disturbances precipitated by the hurricane.

In 1990 the VAMC program acquired an outpatient PTSD Clinical Team and in 1992, a Specialized Inpatient PTSD Unit which are administered as an integrated program. These expanded resources provide further opportunities for clinical research. Several of the program's clinicians have begun to develop projects related to their clinical activities. These include an evaluation of the applicability of computer-based psycho-educational programs to PTSD populations that is being conducted by Michelle Tremont, MA, and Tim Starkey, PhD; investigation of the nature and clinical correlates of psychotic symptoms occurring in a subgroup of patients with severe, chronic PTSD being conducted by Nita Kumar, MD, and Gary Kutcher, PhD; and a description of the impact of Hurricane Andrew on clinical symptoms in combat veterans already enrolled in outpatient treatment undertaken by Elizabeth Jackson, MD. Overall, there has been increasing utilization of the VA clinical programs by the large and ethnically diverse war veteran populations that reside in the South Florida area. Hopefully this will continue to stimulate clinical research activity that will include foci remaining to be developed.

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